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ABSTRACT

The approach taken to chemical engineering education at New Mexico State University is described in this report. The curriculum model for its undergraduate and graduate program emphasizes both content and skill development. Involvement in tasks related to ongoing research projects is stressed and serves as the basis for course assignments at the freshman and first year graduate level. Specific information is provided by way of tables and figures. These include: (1) the undergraduate chemical engineering curriculum model; (2) a listing of important skills for chemical engineers; (3) a graduate chemical engineering curriculum model, and (4) examples of course assignments developed from research. (ML)

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THE DEVELOPMENT OF COURSE ASSIGNMENTS IN CHEMICAL ENGINEERING FOR FRESHMEN AND FIRST YEAR GRADUATE STUDENTS FROM CHEMICAL ENGINEERING RESEARCH

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Introduction

The chemical engineering department at NMSU offers the B.S. and M.S. degrees in chemical engineering. It also offers an interdisciplinary doctorate degree. Research in our department is conducted in kinetics, process control, enhanced oil recovery, two phase flow, and bioengineering. Our department is rapidly evolving into a department having more emphasis than ever before in research. The question then arises: does this mean less emphasis on teaching? The answer is that it means somewhat changed teaching methodologies which lead to both improved teaching and more research. Indeed, one of our faculty is fond of saying that "research is teaching." This is certainly true at the graduate level and can even be true at the undergraduate level when due allowance for background limitations is made.

We have been undergoing fairly rapid changes in the undergraduate and graduate courses while remaining largely within the same course structure. Last year, I reported to this conference on the implementation of our Guide to Writing and Problem Solving for Chemical Engineers. Since then, we have had a contract offer from one commercial publisher and a feeler from a second for our Guide. What is the longer range goal of our efforts? To strengthen our department at all levels. This means building on the sound foundation of developing basic skills. But more than this, by incorporating an increased research component into both undergraduate and graduate classes, we enhance student motivation and give the student a vision of where his chosen discipline can lead. This is important because the work load can be very heavy. The heavy work load is required to make the student capable to handle the sometimes subtle and difficult problems he must face in his professional life. Professional life in chemical engineering can have important components of technical and economic evaluation, hands-on operation, and interpersonal interaction. Chemical engineers work in a very wide variety of organizations. Thus, a sense of confidence, competence, and vision should be instilled in our students. This will make their success in our rapidly changing world more likely.

Skills Needing Development

If research is to enhance teaching, then we must pose the question: what is it that we want our students to learn? Since technology and culture change over time, we want first

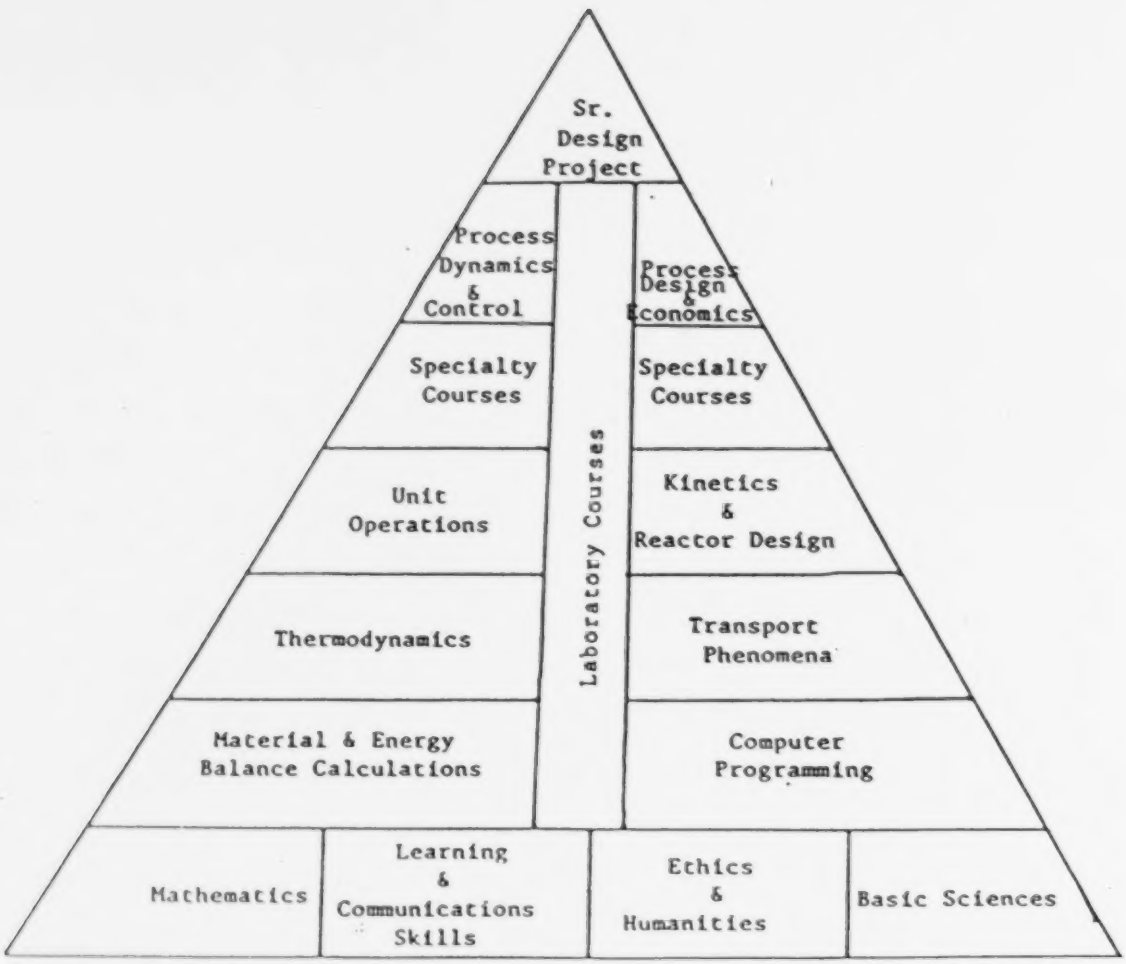
to have our course materials up-to-date at all times so that the factual content is both accurate scientifically and reflects current practice. This means that a continual upgrading of course materials is required. Research can help in this effort by keeping the curriculum at the "leading edge" of practice. Second, we want to be sure that our students graduate knowing how to think and learn for themselves. This second grouping of skills is especially enhanced by developing course assignments from research.

An ABET accredited undergraduate chemical engineering curriculum model is shown in Figure 1.

This organization emphasizes the "content." Content is, of course, crucial to producing competent graduates. But we must remember that content based education is also a way of conveying skills. Table I is a listing of some of the skills important to chemical engineers in practice. Figure 2 presents a graduate curriculum model.

Keeping in mind that both the freshman and first graduate student courses are where the instructors encounter the greatest heterogeneity of student populations, how can we build student motivation, give a "vision", and keep the instruction in balance so that we can rapidly bring all (or most) students to a high level of skill development? This is one of the real "arts" of the teaching profession. As we all know, some students have to be pushed, some have to be pulled, and some have to be sat on.

The insertion of tasks based on current research problems as course assignments into the curriculum at the "beginning" student level is especially effective at focusing the attention of all students on the task. Our experience has been very favorable indeed with course assignments developed from on-going research programs. When the assignments are reasonably matched to the level of student preparation, they do indeed capture the imagination of the student. Because the student knows that he is confronted with a part of a "current" problem in technology, students usually finds the problem highly interesting. Indeed such assignments are usually sufficiently motivating to the student to encourage him to maximum effort regardless of any deficiencies in background he may have. Thus research based course assignments go a long way towards raising overall student performance levels in our classes.



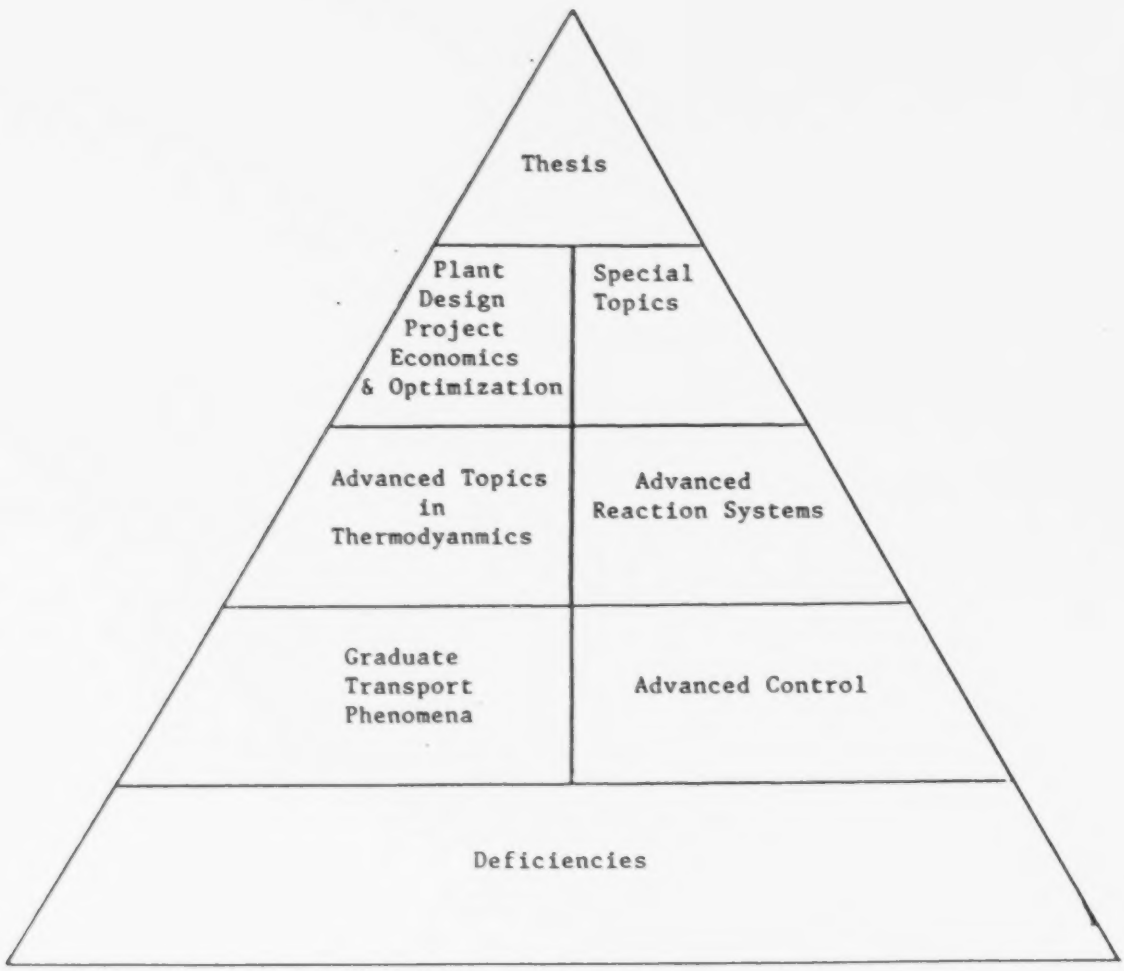
An Undergraduate Chemical Engineering Curriculum Model

Figure 1

TABLE I

Important Skills for Chemical Engineers

Skill	How Taught
Writing	Report Assignments
Problem Solving	Homework
Programming	Problem Assignments
Information Retrieval	Library Research for Special Problems/Projects
Critical Evaluation	Design Projects
Systematic Observation	Laboratory
Handling Apparatus	Laboratory
Safety	Laboratory



A Graduate Chemical Engineering Curriculum Model

Figure 2

TABLE II

Example Course Assignments Developed from Research

Student Level	Course Assignment	Source
Freshman	Computer Programs	Two Phase Flow Project – data treatment
Freshman	Technical Report Writing	Closed Cycle Greenhouse Project
Freshman	Memorandum Writing	Two Phase Flow Project
First Year Graduate	Dimensional Analysis	Two Phase Flow Project
First Year Graduate	Mass Transfer Modeling	Rising Thin Film Absorber Project (Patent Pending)
First Year Graduate	Axial Migration Model	Two Phase Flow Project

Example Course Assignments

While the knowledge and skill levels of freshman and first year graduate students are vastly different, there are some parallels between the two groups. These parallels are based on the fact that both groups are at the beginning of a new phase in their educations. Since the methods and emphases of the undergraduate and graduate curricula are different from the previous experience of the student (high school for one group and undergraduate education for the other group), the student is comparing his expectation to what he actually encounters. Thus, the introductory courses at both levels are crucial to the student's perception of what he can expect to get out of the curriculum. It behooves us, as educators, therefore, to make these beginning courses as interesting as possible for the student.

In our department we have used tasks related to several ongoing research projects as the basis for course assignments at the freshman and first year graduate level. These are summarized in Table II.

Conclusions

Education in chemical engineering at the undergraduate and graduate levels consists of both content and skill development. It is therefore essential to keep content current and insure that the teaching methods develop the desired student skills. In this way, we enhance the general level of success of our graduates. The development of course assignments from research helps us to maintain currency in course content and enhances skill development in students by increasing their interest in the task at hand.

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